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Adams

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[54] **INCINERATOR, INCINERATION SYSTEM AND METHOD**

[75] Inventor: **Jack C. Adams**, York, Pa.

[73] Assignee: **Ecologenics Corporation**, Red Lion, Pa.

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[52] **U.S. Cl.** .... **110/8 C**; 110/8 P; 110/15; 110/119

[51] **Int. Cl.**[2] **F23G 5/12**

[58] **Field of Search** .... 110/7 R, 8 R, 8 A, 8 C, 110/10, 15, 8 P, 119

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Primary Examiner—Kenneth W. Sprague

[57] **ABSTRACT**

Comminuted waste material is inserted into an upper section of a vertically directed incinerator. The incinerator includes a plurality of vertically contiguous zones. A blower is connected to an outlet port of the incinerator to adjust the flow rate of combusting gases within each of the incineration zones. The blower provides a force on the combusting gases opposite to a thermal updraft force which permits control of the flow of the gases in a manner resulting in spontaneous combustion of the waste material.

27 Claims, 5 Drawing Figures

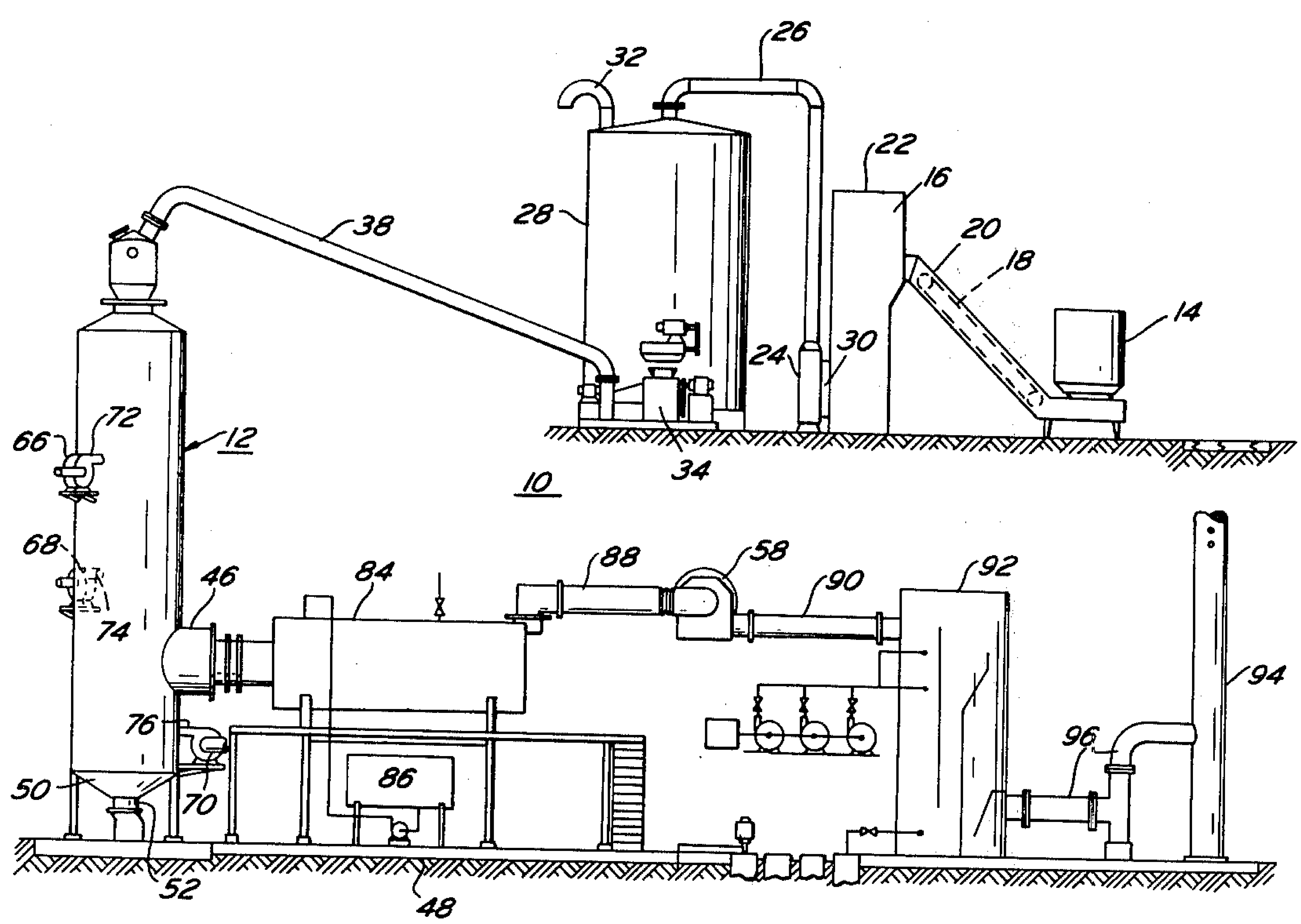

FIG. 1

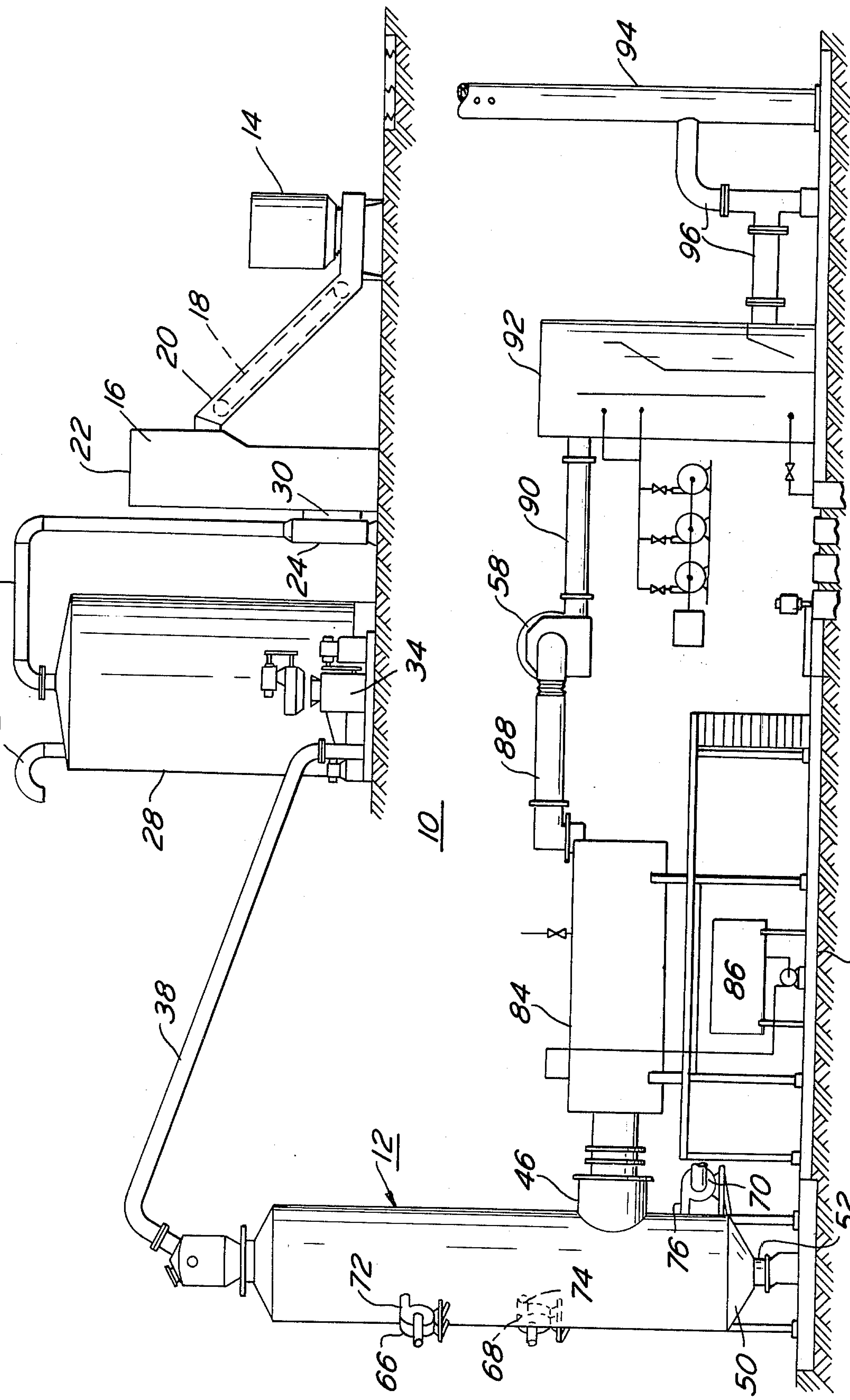

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FIG. 2

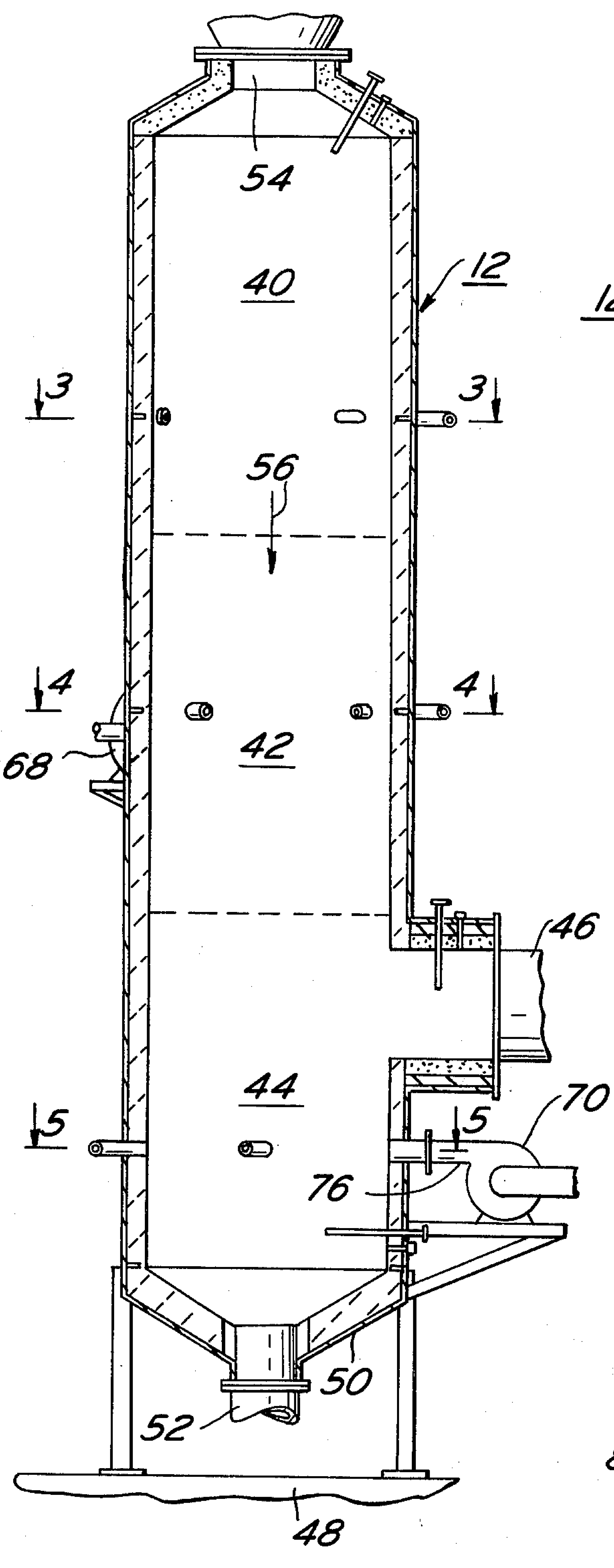

FIG. 3

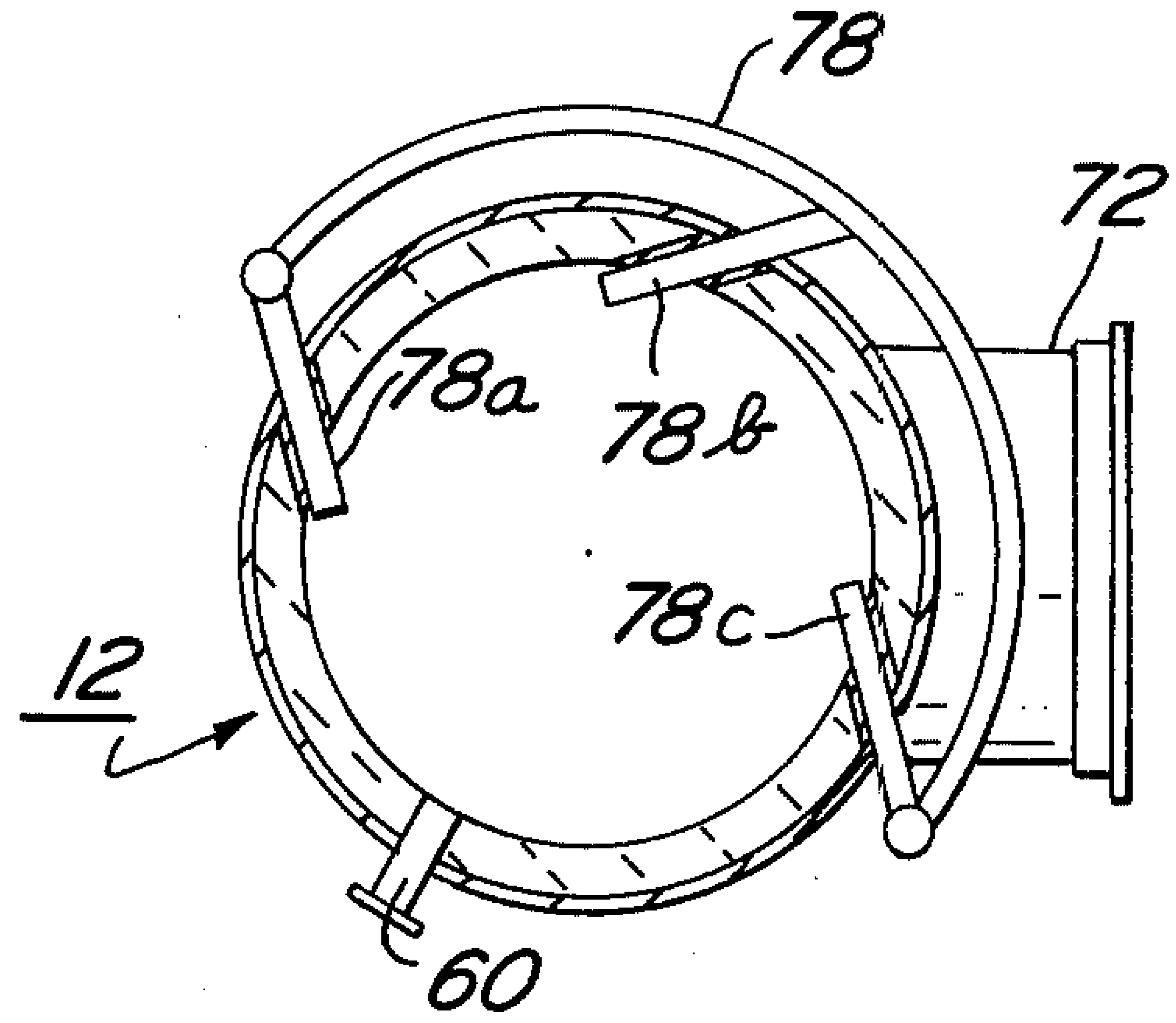

FIG. 4

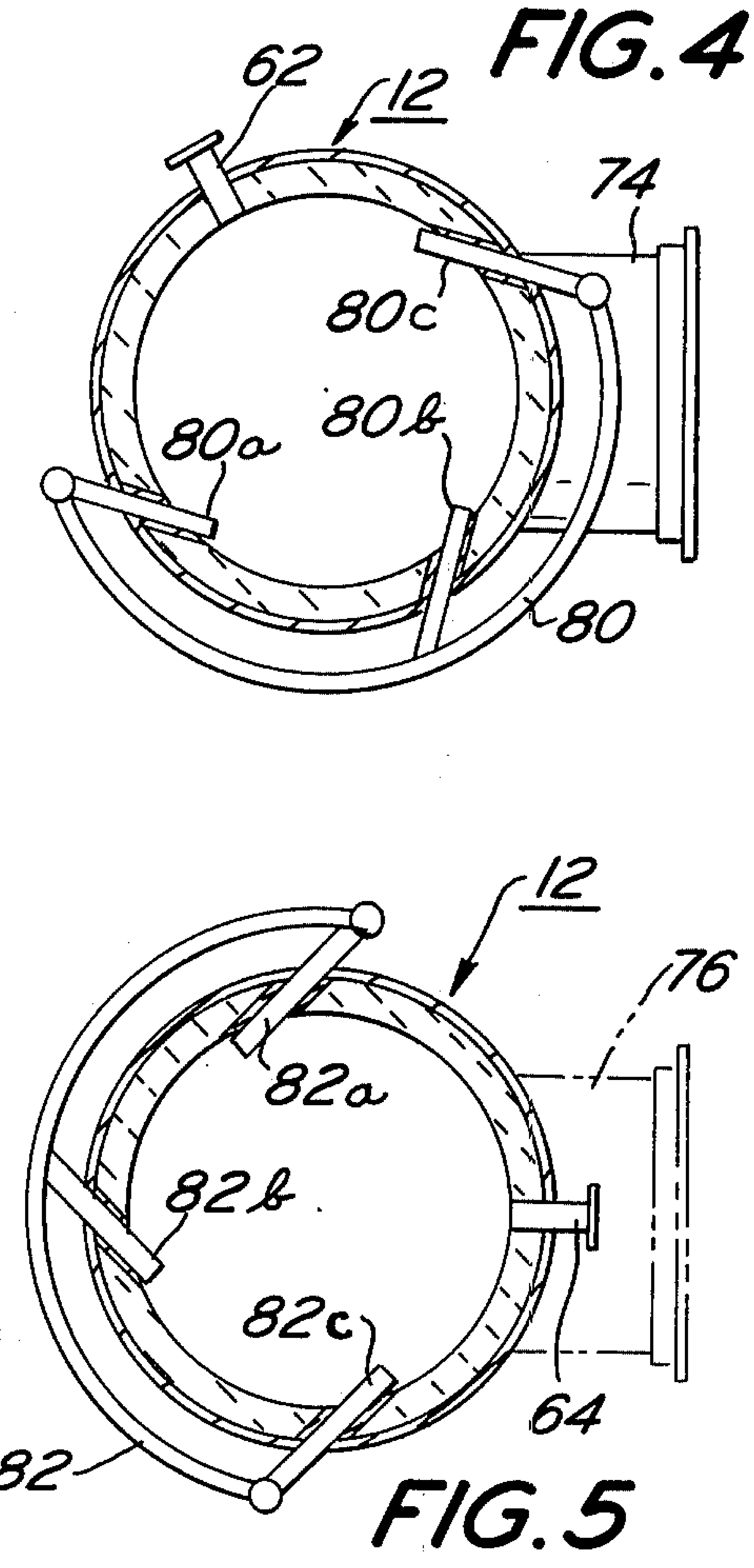

FIG. 5

INCINERATOR, INCINERATION SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

A. Field of the Invention

This invention pertains to the field of incineration. In particular this invention relates to incinerator systems to provide spontaneous combustion of waste material within an incinerator.

B. Prior Art

Incineration systems and methods of incinerating waste materials are known in the art. However, in many systems incineration is accomplished by continuous burning of fuel fired burners which results in the use of excessive amounts of fuel. This use of fuel results in high incineration operating costs as well as an undesirable drain of fuel resources.

In some incinerator systems, combustion is accomplished in a vertically directed chamber. However, in many such type incineration systems the rate of flow of combustion gases is uncontrolled. Thus, large quantities of uncombusted waste material is derived from these systems as an unwanted by-product. Such uncombusted waste material results in a low operating efficiency of these incinerator systems.

In other vertically directed incineration chambers, large quantities of excess air must be incorporated to promote burning of the waste material. Such incorporation of excess air increases the operation costs of the incineration system. Further, such incorporation of excess air often has the effect of providing uncontrolled burning of the waste material and results in portions of the waste material remaining in an uncombusted state.

Summary of the Invention

A waste material incineration method which initially includes the step of comminuting the waste material to a predetermined size. The comminuted waste material is then inserted into a vertically extending incinerator. The flow rate of the waste material combustion gases is adjusted through a plurality of vertically contiguous zones within the incinerator to provide spontaneous combustion of the comminuted waste material within the incinerator.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view of the incineration system showing the flow of the waste material from insertion into a receiving bin to exhaust of waste gases to an external environment;

FIG. **2** is a section elevation view of the incinerator showing an initial combustion zone, a second combustion zone, and a third combustion zone;

FIG. **3** is a sectional view of the incinerator taken along the section line **3—3** of FIG. **2;**

FIG. **4** is a sectional view of the incinerator taken along the section line **4—4** of FIG. **2;** and

FIG. **5** is a sectional view of the incinerator taken along the section line **5—5** of FIG. **2.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. **1,** there is shown waste disposal system **10** for use in disposing of residential, commercial, as well as industrial refuse. In overall concept, system **10** promotes rapid incineration of a suspension of waste material within refractory lined incinerator **12** and results in substantially complete combustion of the waste material combustible components. System **10** further utilizes the gaseous waste heat emitted from incinerator **12** to generate steam within boiler **84.** As part of system **10,** waste gases are then cleansed before insertion into the external environment. Incorporation of the waste material into vertically directed incinerator **12** and associated incineration of the refuse or waste material in suspension throughout its passage within incinerator **12** by controlled gravity assist provides for spontaneous combustion of the inserted waste material. This combustion technique allows a minimum amount of excess air to be inserted within incinerator **12** for combustion purposes which effectively minimizes problems associated with resulting contamination of the external environment.

As shown in FIG. **1,** waste material or refuse is initially incorporated into receiving bin **14** for transport to primary shredder **16.** The waste material is moved between bin **14** and shredder **16** on endless conveyor **18** passing within bin conduit **20.** The waste material passes internal to primary shredder housing **22** at an upper portion thereof to provide storage volume for the incoming waste material. Primary shredder **16** reduces the waste material particles to a maximum of approximately 3 inch lengths. Primary shredder **16** may be of the hammer-type mill, one of which is produced by the Bryant-Poff Corporation having a designation of Model No. 50X36 Big-Pro Shredder or some like shredding device not important to the inventive concept as herein detailed.

The waste material now residing in primary shredder **16** and having a size nominally less than 3 inches in length is drawn from primary shredder **16** by shredder blower **24** to be passed through blower conduit **26** into silo **28.** Shredder blower **24** is connected to a lower section of primary shredder housing **22** through blower insert piping **30** to provide a continuous through passage from a lowermost section of primary shredder **16** to an upper section of silo **28.** Shredder blower **24** may be of the centrifugal type which is well known in the art and may be the same type used on the previously referenced No. 50X36 Big-Pro Shredder produced by Bryant-Poff.

Waste material having been initially shredded in primary shredder **16** is then inserted into an upper portion of silo **28** which may be used as a storage area prior to insertion within incinerator **12.** Waste material entering silo **28** passes to an equilibrium position by gravity assist. Silo **28** includes vent pipe **32** which is connected to a trap for collection of possible waste material particles that are being driven into silo **28** at a high pressure. Vent pipe **32** and an associated trap (not shown), which are not part of the inventive concept are utilized to prevent contamination of the external environment. Secondary shredder **34** is connected to an internal portion of a lower section of silo **28** to provide secondary comminution of the waste material residing within the storage area of silo **28.** Secondary shredder **34** has as its purpose to provide a second comminution of the waste material which results in the waste material having a size nominally less than 1 inch. Secondary shredder **34** is well known in the art, one such type having been successfully used is the Bryant-Poff Model No. 3600-25. Secondary shredder blower **36** provides the necessary pressure differential to transport the now twice comminuted waste material through incinerator conduit **38** into vertically extending incinerator **12.**

Secondary shredder blower **36** may be the same centrifugal type used on the No. 3600-25 shredder **34**, or some like device.

The finely divided particles of waste material are now inserted into an uppermost portion of vertically displaced incinerator **12**. In overall concept, the particulates are spontaneously combusted in their passage through three major zonal areas within incinerator **12**. The waste material particles pass through initial combustion zone **40**, second combustion zone **42**, and third combustion zone **44** before the heated combustion gases exit from incinerator **12** through side outlet port **46** as is shown in FIGS. **1** and **2**. In general, incinerator **12** vertically extends above ground **48** in order to provide gravity assist for the waste material particles being combusted in suspension throughout combustion zones **40**, **42**, and **44**. Incinerator **12** may include conically shaped floor **50** and associated ash removal port **52** to facilitate discharge of ash products from incinerator **12**. Ash removal may be provided by passage of resulting ash through ash removal port **52** into a storage bin which may be removed at the completion of any particular cycle, however, such is not important to the inventive concept as is herein detailed. The internal walls of incinerator **12** is in general lined with high temperature refractory brick which can withstand the elevated temperatures resulting during the combustion process.

After initially elevating the interior volume of incinerator **12** (to be discussed in following paragraphs), the waste material enters incinerator **12** through upper port **54** and falls into initial combustion zone **40** where it begins to spontaneously combust and is heated into a first elevated temperature range. In actual practice, the temperature measurements within initial combustion zone **40** have been maintained within an approximating range of 1750° – 1920°F. The initially combusting waste material then passes into second combustion zone **42** in the direction of gravity vector **56** through gravity assist. The combusting products are heated further into a temperature range higher than those found in the initial combustion zone **40**. Actual tests have shown that second combustion zone **42** temperatures are in the neighborhood of 2000°F. The increase of temperature of the combusting products has been found to give rise to thermal currents which displace the combusting gases upward in a direction opposing gravity vector **56** to provide some reentrance of the combustion gases into initial combustion zone **40**.

It is believed that the rise of gases within second combustion zone **42** into initial combustion zone **40** results from natural convection currents. Such displacement or transport of the combustion gases in an upward direction is important to the inventive concept since the flow of gases through side outlet **46** may now be rigidly controlled through actuation of downstream blower **58** which is further described in following paragraphs. It is believed that the up draft of combustion gases from second combustion zone **42** into initial combustion zone **40** provides for a means whereby there is one force in the direction of gravity vector **56** acting on the combusting gases, namely, the gravity force which acts in combination with an opposing updraft force provided by the differences in temperature between zones **40** and **42**. Thus, where a pressure differential is applied by blower **58**, there is now an additional downward force acting on the combusting gases. The blower force acting in concert with the gravity force but opposite to the convection force permits control of the flow rate of the suspended waste material gases to provide each of zones **40**, **42** and **44** with a predetermined temperature range which results in spontaneous combustion.

After passage of the combusting particles through initial and second combustion zones **40** and **42** which serve as an overall primary combustion zone, the remaining combusting gases pass into third combustion zone **44** which may serve as a secondary combustion zone. Temperatures being measured in third combustion zone **44** have been found to be somewhat lower than temperature range within initial and second combustion zones **40** and **42**. Temperature ranges in third combustion zone **44** for one design of incinerator **12** have been found to be within an approximate range of 1300° to 1550°F.

By providing a vertically extended incinerator **12** through which waste material passes from an upper port **54** to a lower side outlet port **46** in combination with one combustion zone **42** at a higher temperature than another combustion zone **40** temperature, a thermodynamic environment is created whereby gas transport forces may act in opposing directions. When this combination of forces is then acted on by a pressure differential provided by blower **58**, shown in FIG. **1**, a controlling mechanism is set up whereby the flow rate and the temperatures in each of the zones **40**, **42** and **44** may be adjusted to provide spontaneous combustion with a minimum insert of excess air.

It will be noted that where specific combustion zones and the maintenance of particular temperatures therein is not controlled, there would be the tendency to obtain a high temperature in an upper portion of incinerator **12**. The gases would then pass to a lower portion of incinerator **12** only through gravity assist. This would not provide a controlled displacement for the movement of the combusting gases. Such an arrangement would necessarily not provide for complete combustion of the waste material and at best would require excessive amounts of air being inserted into incinerator **12** to provide combustion.

Within each of combustion zones **40**, **42** and **44**, there is provided a means whereby the interior of incinerator **12** may be initially heated into a temperature range approximating 1800°F. to provide an environment where the incoming waste material may begin to spontaneously combust. As is shown in FIGS. **3**, **4** and **5**, initial oil burner **60**, second oil burner **62**, and third oil burner **64** associated respectively with combustion zone **40**, **42** and **44** are inserted through a sidewall of incinerator **12** to provide the initial heating of the internal volume. Oil burners **60**, **62** and **64** are well known in the art and such may be York-Shipley burners having a Model No. FV20B-2. Additionally, each of zones **40**, **42** and **44** include supplementary or excess air blowers **66**, **68** and **70** as is shown in FIG. **1**. Each of supplementary air blowers **66**, **68** and **70** are mounted to external wall of incinerator **12** and pass air through respective conduits **72**, **74** and **76**. Looking at the initial combustion zone **40** air supply, it is seen that air is taken through a main excess air conduit **78** passing around the periphery of a sidewall of incinerator **12** and extending throughout a substantial segment thereof. Connected to main excess air conduit **78** is a plurality of subsidiary air pipes **78*a***, **78*b*** and **78*c*** which pass through a sidewall of incinerator **12** and are angled with respect thereto to provide vortexing of the incoming air. In like manner, air insert piping **80*a***, **80*b*** and

80*c* provide vortexed incoming excess air into second combustion zone **42.** Similarly, air excess conduits **82***b*, **82***c* and **82***a* provide vortexed air inlet into third combustion zone **44.** The vortexing of the air has been found to aid in the combustion of the waste materials in a twofold manner: (1) by creating turbulence to increase heat transfer throughout the combusting particles in each of the combustion zones; and (2) by providing movement of the combusting particles within each of the combusting zones to achieve more homogeneous burning in a zone. Each of blowers **66, 68** and **70** are well known in the art and may be of the type produced by the Lau Corp. having a model No. HPR-12.

The resulting exhaust gases pass through outlet port **46** of incinerator **12** to boiler **84** to provide waste heat recovery. One such type boiler **84** which has been used successfully is the York-Shipley series **596** heat exchanger rated at 700 horsepower. Boiler **84** may include feed water pump **86** which is well known in the art.

The exhaust gases after passing through boiler **84** enter boiler conduit **88** to be drawn into blower or fan **58.** Blower **58** may be of the induction type produced by Buffalo Forge Corp. and having a designation Size 60, Type MW. In actual practice induction fan **58** produces up to 0.5 inch pressure drop within incinerator **12.**

By empirically adjusting the pressure drop for blower **58,** the rate of flow of combustion gases through incinerator **17** may be adjusted as has been described. This flow rate may be utilized to maintain predetermined temperatures within each of combustion zones **40, 42** and **44** to provide spontaneous combustion. Thus, by downstream actuation of a pressure drop, the spontaneous combustion of the waste material internal to incinerator **12** is maintained.

Exhaust gases pass through appropriate piping **90** to scrubber unit **92** in order to cleanse the waste gases of harmful emissions. Scrubber unit **92** may be of the baffled spray type, one such type being commonly used and well known in the art is produced by Chemical Equipment Co. The cleansed waste material passing from scrubber unit **92** is then brought into stack **94** through associated contour piping **96** and exhausted to the external environment.

What is claimed is:

1. A waste material incineration method including the step of:

a. comminuting said waste material to a predetermined size;
b. inserting said comminuted waste material to a vertically extending incinerator; and
c. applying a pressure differential to said incinerator throughout said vertical extension of said incinerator to control a flow rate of said comminuted waste material combustion gases through a plurality of vertically contiguous zones within said incinerator to provide spontaneous combustion of said comminuted waste material within said incinerator.

2. The method of waste material incineration as recited in claim **1** where the step of applying said pressure differential to said incinerator includes the step of maintaining a predetermined temperature in each of said incinerator zones whereby said comminuted waste material is spontaneously combusted.

3. The method of waste material incineration as recited in claim **2** where the step of maintaining said predetermined temperature includes the step of inserting a predetermined flow rate of air into said incinerator zones.

4. The method of waste material incineration as recited in claim **2** where the step of maintaining said predetermined temperature includes the step of applying a force to said combusting material in the direction of a gravity vector to oppose an updraft force applied to said combusting material in a direction opposing said gravity vector.

5. The method of waste material incineration as recited in claim **4** where said gravity vector force is greater than said force in said direction opposing said gravity vector.

6. The method of waste material incineration as recited in claim **1** where the steps of: comminuting said waste material includes the step of initially shredding said waste material to a predetermined initial size, and; storing said initially shredded waste material in a chamber.

7. The method of waste material incineration as recited in claim **6** where the step of initially shredding is followed by the step of passing said waste material through a secondary shredder for reducing said initial size of said waste material prior to said insertion within said incinerator.

8. The method of waste material incineration as recited in claim **1** where said comminuted waste material is inserted into an uppermost section of said vertically extending incinerator.

9. The method of waste material incineration as recited in claim **1** including the step of passing the resulting gases of said combusted waste material through a boiler for producing steam.

10. The method of waste material incineration as recited in claim **1** including the step of drawing said resulting gases of said combusted waste material into a gas scrubber for removing contaminents from said combusted waste material gases.

11. The method of waste material incineration as recited in claim **10** where the step of drawing said resulting gases into said gas scrubber is followed by the step of exhausting said gases to an external environment.

12. An incinerator for combusting waste material, comprising:

a. waste material combustion means forming a vertically extending enclosed chamber having a plurality of vertically contiguous combustion zones; and,
b. means for applying a predetermined pressure differential across said contiguous combustion zones within said combustion means for controlling a flow rate of said combusting waste material through said combustion zones to provide spontaneous combustion of said waste material within said combustion means.

13. The incinerator as recited in claim **12** where said pressure differential means includes means for applying a force to combusting waste material gases in a direction substantially coincident with a gravity vector.

14. The incinerator as recited in claim **13** where said force being applied to said combusting waste material gases in said direction coincident with said gravity vector is opposed by a thermal updraft force acting on said combusting waste material gases.

15. The incinerator as recited in claim **12** where said pressure differential means includes blower means connected to an outlet port of said combustion means located in a lower section thereof, said blower means for creating a negative pressure differential across said combustion zones.

16. The incinerator as recited in claim **15** where said blower means applies a downwardly directed force to said combustion waste material gases, said downwardly directed force substantially opposing a thermal updraft force being applied to said combusting gases within said enclosed chamber.

17. The incinerator as recited in claim **12** where said waste material combustion means includes means for elevating said chamber combustion zones to a temperature substantially equal to a combustion temperature of said waste material prior to the insertion of said waste material within said combustion means.

18. The incinerator as recited in claims **17** where said temperature elevation means includes burner means within each of said vertically contiguous zones of said enclosed chamber.

19. The incinerator as recited in claim **12** where said waste material combustion means includes means for inserting excess air into each of said combustion zones for aiding in the maintenance of a predetermined temperature in each of said zones.

20. The incinerator as recited in claim **19** where said excess air means includes means for vortexing said inserted air in a direction normal to a gravity vector within said enclosed combustion chamber.

21. A waste material incineration system comprising:

a. means for comminuting said waste material to a predetermined size;

b. incinerator means connected to said comminution means for receiving said comminuted waste material at an upper section; and,

c. means for adjusting a flow rate of said comminuted waste material combustion gases through a plurality of vertically contiguous zones within said incinerator means by applying a predetermined pressure differential across said contiguous zones for providing a thermodynamic environmental condition receptive to spontaneous combustion of said comminuted waste material.

22. The waste material incineration system as recited in claim **21** where said flow rate adjustment means includes means for maintaining a predetermined temperature within each of said contiguous zones within said incinerator means.

23. The waste material incineration system as recited in claim **22** where said temperature maintenance means includes means for applying a force to said combusting material gases in a direction coincident with a gravity vector to oppose a thermal updraft force applied to said combustion waste material gases.

24. The waste material incineration system as recited in claim **21** including boiler means connected to a lower section of said incinerator means for passing combusted waste material gases therethrough to produce steam.

25. The waste material incineration system as recited in claim **24** including blower means connected to said boiler means for: (1) drawing said combusted waste material gases through said boiler, and (2) applying a predetermined pressure differential across said contiguous zones within said incinerator means.

26. The waste material incineration system as recited in claim **21** where said incineration means includes means for elevating temperatures, prior to the insertion of said waste material, within each of said contiguous zones to a predetermined temperature range to provide spontaneous combustion of said waste material.

27. The waste material incineration system as recited in claim **26** where said temperature elevation means includes burner means within each of said contiguous zones.

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